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(71) Applicant
Mannesmann Aktiengesellschaft, (F. R. Germany), Mannesmannufer 2, D-4000 Dusseldorf, Federal Republic of Germany

(72) Inventors
Horst Euler,
Hans-Joachim Meyer,
Fritz-Peter Pleschiutschnigg

(74) Agent and/or address for service
Brookes & Martin, High Holborn House, 52—54 High Holborn, London, WC1V 6SE

(54) Improvements in continuous casting

(57) The outer surface of a mould tube 2 has generally axially extending grooves 16 at its upper end to improve the effect of coolant flowing through a gap 6 between the mould tube 2 and a guide tube 7. The grooves may wind helically about the mould tube and may have rounded bottoms or be of a trapezoidal section.

Fig. 1

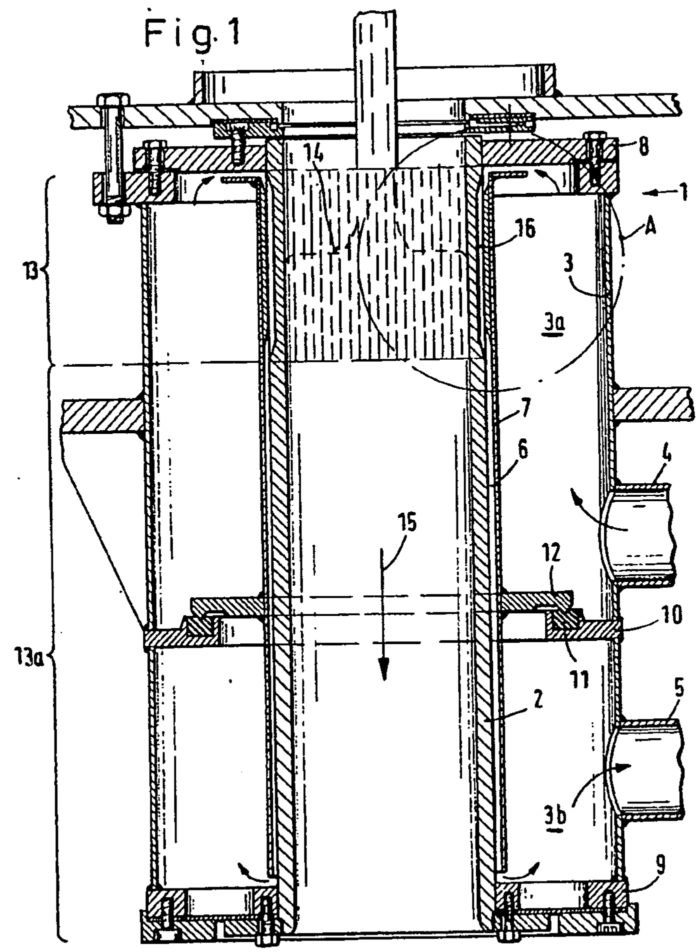

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Fig. 1

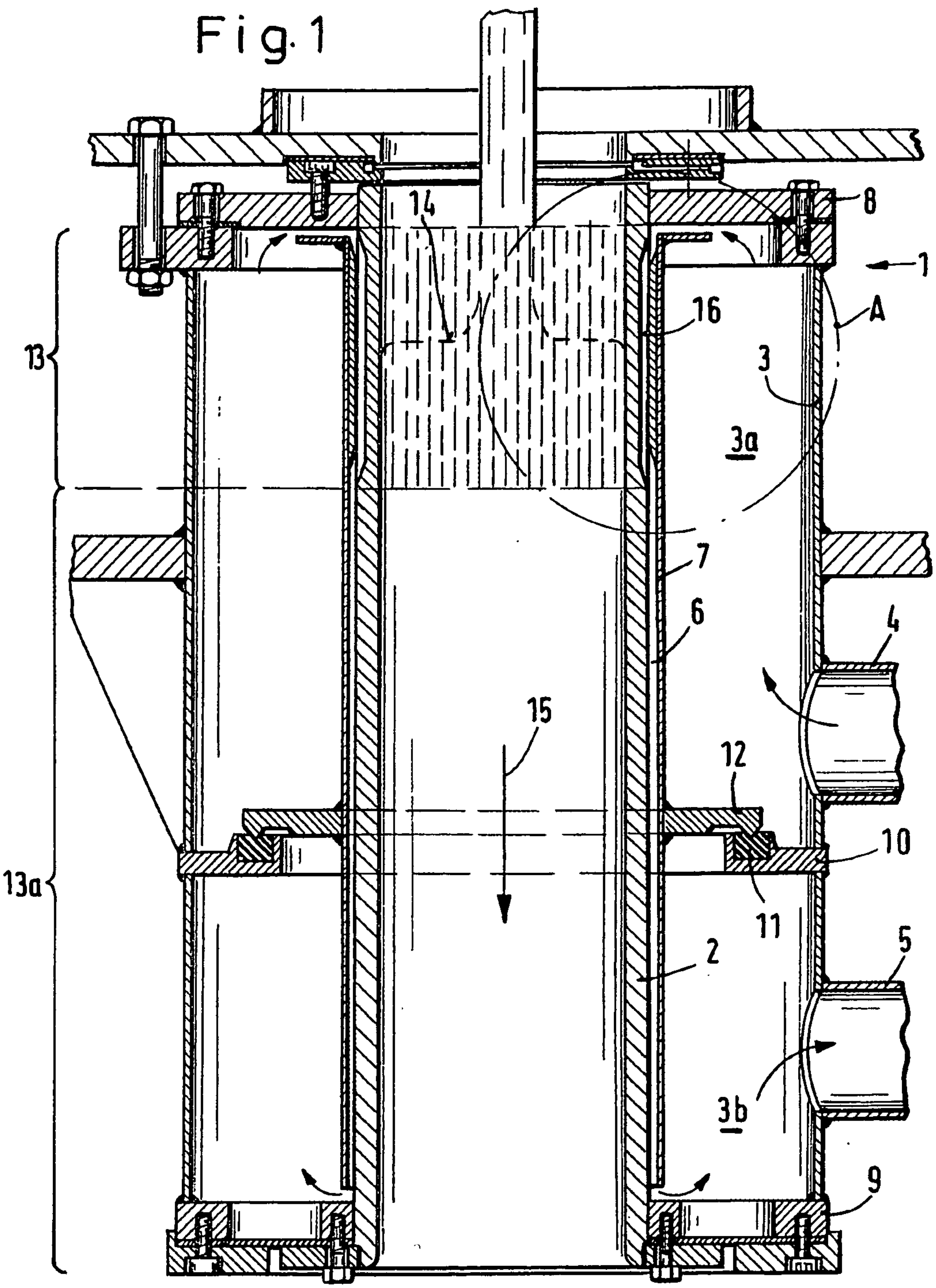


Fig. 2

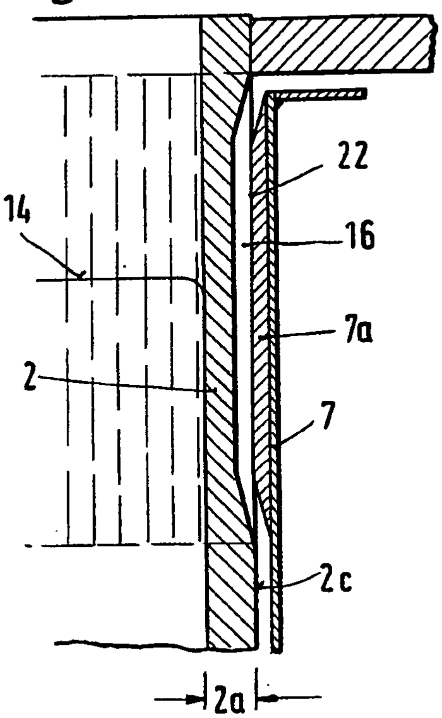
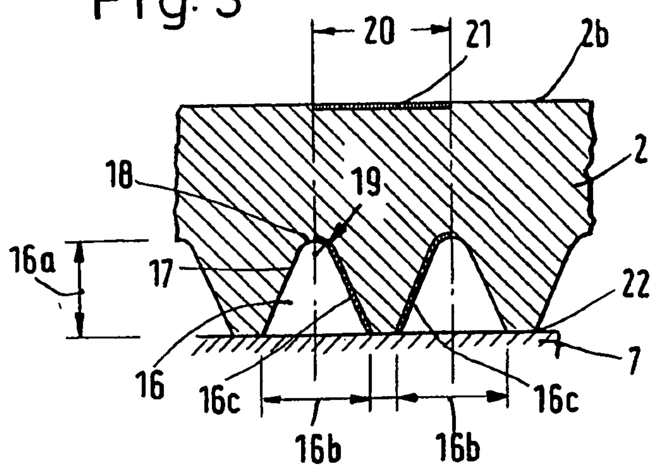


Fig. 3



SPECIFICATION

Improvements in Continuous Casting

It is well known to produce cylindrical rods and billets by the continuous casting of steel and other metals. The mould which is used may be of the type disclosed in patent specification No. 2 115 328 and have a mould tube surrounded by a coolant container with a coolant inlet and a coolant outlet. The mould tube is surrounded by a coolant guide tube which, together with the mould tube, forms an annular coolant gap or clearance open to the interior of the coolant container and through which the coolant flows.

Continuous casting moulds of this type are used predominantly for producing continuously cast material from nonferrous metals and steel. The cast strand may take the form of billets with sides of between 70 and 200 mm and rods with diameters of from 100 to 500 mm.

The mould tube may have a wall thickness of about 12 mm and smooth interior and exterior surfaces for reasons of production and economy. The coolant guide tube surrounding the mould tube may have a wall thickness of about 4 mm and define with the mould tube a gap or clearance with a width of from about 6 to 8 mm. A mould tube of this type has a maximum service life of about 150 charges when casting steel, after which it must be replaced.

The continuously cast strand sometimes differs in shape from the theoretical, for example the strand actually cast may have a cross-sectional shape with the form of a rhomboid instead of a theoretical square cross-section. Although circular cross-sections are not subject to these distortions, cracks sometimes appear in the cast material. Moreover, circular mould tubes have been found to be cracked as the result of heating and cooling.

The present proposal seeks to reduce the tendency of undesirable cooling to distort the cast material and damage the continuous casting mould.

Accordingly, it is proposed that the external surface of the mould should have therein generally axially extending grooves, at least in the upper region of the mould tube. This feature serves to reduce the temperature on the cooled side of the mould tube. The heat is carried off relatively uniformly throughout the periphery of the tube so that thermal stresses in the cast material and in the continuous casting mould, i.e. overheating of the mould tube, are avoided. As a result a billet intended to be of square section is less likely to be of rhomboidal form, and thermal damage to the continuous casting mould is less likely to occur.

The grooves may be arranged solely in the region of the predetermined casting surface level and may extend helically around the mould tube. This feature increases the reliability of the cooling action, even if the coolant, such as water, does not meet all the requirements with respect to purity. The grooves may be approximately trapezoidal in cross-section to increase the cooling surface and thus the intensity of cooling.

The possible drawbacks of grooves formed in relatively thin-walled mould tubes (for example, fatigue notches) are avoided by giving the grooves rounded bottoms.

To render the mould tube sufficiently stable to mechanical and thermal stresses, it is proposed that the wall thickness of the mould tube and the depth of the grooves have a ratio of at least 2.4:1 or greater.

Overheating and resulting changes in the structure of the mould tube may be best avoided by ensuring that the area of the cooling surfaces on the outer side of the tube and located within a zone defined between adjacent grooves totals about 1.4 to 2.0 times more than the area of the surface which lies within this zone and is wetted by the molten metal on the interior of the mould tube. The cooling conditions for the cast material and the material of the mould tube may also be improved by causing the coolant to flow through the grooves with a velocity of about 10 to 12 m/sec. The velocity of coolant through the grooves may be increased without increasing the supply to the mould by making the clearance between mould tube and coolant guide tube smaller in the upper, grooved region than in the lower ungrooved region.

The increase in velocity can be transferred completely to the grooves if no clearance exists between mould tube and coolant guide tube in the grooved region.

In order to keep the thermal stress applied to the mould tube within tolerable limits, it may also be advantageous to reinforce the coolant guide tube in the region of the grooves.

It is also proposed that flow of coolant through the grooves and the cooling gap be from top to bottom. The high pressure of the coolant (for example, water) raises the temperature at which the coolant boils in the hottest region of the mould tube, so that formation of bubbles and, therefore, defective cooling are avoided in the region of the casting level. A pressure drop and resulting reduction in velocity is also restricted to lower regions of the mould tube.

In the drawings:—

Figure 1 is an axial longitudinal section through the proposed continuous casting mould.

Figure 2 shows a detail "A" from Figure 1 to an enlarged scale.

Figure 3 is a cross-section through the cooling grooves also to an enlarged scale.

The continuous casting mould 1 shown in Figure 1 may be used, depending upon the cross-sectional shape of the mould tube 2, for casting billets or cylindrical rods. The mould tube is disposed within a coolant container 3 having a coolant inlet 4 and a coolant outlet 5. The mould tube 2 is surrounded with a clearance by a guide tube 7 so as to define a coolant gap 6, which is annular if the tubes are cylindrical. The mould tube 2 is held inside the continuous casting mould 1 by means of flanges 8 and 9. The coolant container 3 is divided into a coolant header chamber 3a and a coolant return chamber 3b, the two chambers being separated from each other by a flange plate 10 with seal 11 and sealing plate 12. The flanges 8 and 9 are sealingly

connected to the coolant container 3. The gap 6 opens into the two chambers.

Grooves 16 formed in the mould tub extend in the longitudinal direction 15 in the region 13 of the previously determined level for the casting level 14. The grooves 16 illustrated in Figure 1 are straight, i.e. parallel to the longitudinal direction of the mould tube 15. However, the grooves 16 can instead run helically in the external surface 2c of the mould tube 2.

The grooves 16 are approximately trapezoidal 17 in cross-section (Figure 3) with a rounding 19 in the base 18. The mould tube 2 has a wall thickness 2a of, for example 17 mm for reasons of strength, the depth 16a being correspondingly less.

The external width 16b of the grooves 16 determines the cooled surface. The surface 21 on the interior 2b of the mould tube wetted by the molten metal is defined by the area 20 between the centre lines of adjacent grooves 16. This surface 21 is opposite the much greater cooling surface 16c.

The space 22 between mould tube 2 and coolant guide tube 7 is smaller in the upper region 13 than in the lower region 13a, in which there are grooves 16. However, this space 22 can be eliminated, as shown in Figure 3. For reasons of strength, the coolant guide tube 7 can be provided with a reinforcement 7a, which may consist of an increase in the wall thickness (inwardly or outwardly) at least in the region with the cooling slits 16.

The coolant, for example cooling water, flows from top to bottom through the coolant inlet 4 and leaves the coolant return chamber 3b.

CLAIMS

1. A continuous casting mould, in particular for the casting of molten steel, including a mould tube surrounded by a coolant container having a coolant inlet and a coolant outlet, a coolant guide tube disposed within the coolant container and surrounding the mould tube, so as to define a path through which coolant is guided between the two tubes, the external surface of the mould tube having therein generally axially extending grooves, at least in the upper region of the mould tube.

2. A mould according to claim 1, wherein a plurality of axially extending grooves are distributed around the tube.

3. A mould according to claim 1, wherein the grooves extend helically around the mould tube.

4. A mould according to any preceding claim, wherein the grooves are provided only in the region of the predetermined casting surface level.

5. A mould according to any preceding claim wherein the grooves are approximately trapezoidal in cross-section.

6. A mould according to any of claims 1 to 5, wherein the bottoms of the grooves are rounded in cross-section.

7. A mould according to any preceding claim, wherein the ratio of the wall thickness of the mould tube to the depth of the grooves is at least 2.4:1.

8. A mould according to any preceding claim, wherein the area of the cooling surfaces located within a central space between adjacent grooves is in total between about 1.4 to 2.0 times greater than the opposing surface which lies within this central space and is wetted by the molten metal on the interior of the mould tube.

9. A mould according to any preceding claim wherein the velocity of the coolant in the grooves is arranged to be between about 10 to 12 m/sec.

10. A mould according to any preceding claim wherein the space between mould tube and coolant guide tube is smaller in the upper grooved region than in the lower ungrooved region.

11. A mould according to any of claims 1 to 9, wherein there is no clearance between mould tube and coolant guide tube in the grooved region.

12. A mould according to any preceding claim wherein the coolant guide tube is reinforced in the grooved region.

13. A mould according to any preceding claim wherein the coolant inlet and outlet are so arranged that the direction of flow through the grooves is from top to bottom.

14. A mould substantially as hereinbefore described with reference to and as illustrated in the drawings.

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